MONTHLY NOTICES

OF THE

ROYAL ASTRONOMICAL SOCIETY.

VOL. XLVI. MAY 14, 1886. No. 7

J. W. L. GLAISHER, M.A., F.R.S., President, in the Chair.

William Edgar Butcher, H.M.S. *Superb*, Mediterranean Squadron;

J. D. McClure, B.A., 71 Jesus Lane, Cambridge; and

Charles Ridley Smith, 44 Lower Belgrave Street, Eaton Square, S.W.;

were balloted for and duly elected Fellows of the Society.

Comparisons of certain Southern Star Catalogues.

By A. M. W. Downing, M.A.

Finding that I had amongst my papers complete comparisons (*i.e.* giving Δa_a, Δa_δ, $\Delta \delta_a$, and $\Delta \delta_\delta$) of the following Star Catalogues:—

I. The Cape Catalogues for 1840 and 1850,
II. The Cape Catalogues for 1840 and 1860,
III. The Cape Catalogues for 1850 and 1880,
IV. The Cape Catalogue for 1860 and the Melbourne Catalogue for 1870,
V. The Melbourne Catalogue for 1870 and the Cape Catalogue for 1880,

it occurred to me that, as only some of these comparisons had been published, from time to time, as opportunity offered, it would be desirable to publish the remainder, in order to avoid the risk of loss which a further postponement of publication might entail. I accordingly now take the liberty of offering them to the Society, not because they are of any special interest at the present time, but with the hope that they may be of use

to astronomers engaged on researches demanding a knowledge of the systematic discordances of the Star Catalogues above-mentioned.

I. *The Cape Catalogues for* 1840 *and* 1850.

The comparison in Right Ascension when the stars are arranged in order of N.P.D. is given in *Monthly Notices*, vol. xlv. pp. 299, 300. To find the discordances in R.A. depending on R.A., the differences have been arranged in order of R.A., and combined in groups extending each over one hour of R.A., and thus the following mean differences found:—

R.A.	Mean $\Delta\alpha$ 1840–1850.	Number of Stars.	R.A.	Mean $\Delta\alpha$ 1840–1850.	Number of Stars.
h h	s		h h	s	
0–1	−0·160	45	12–13	−0·029	37
1–2	−0·127	46	13–14	−0·004	50
2–3	−0·154	52	14–15	−0·009	36
3–4	−0·087	49	15–16	−0·009	64
4–5	−0·054	50	16–17	−0.060	65
5–6	−0·041	40	17–18	−0·010	62
6–7	−0·070	73	18–19	+0·010	52
7–8	−0·040	71	19–20	−0·062	34
8–9	+0·027	49	20–21	+0·017	29
9–10	+0·066	40	21–22	−0·023	32
10–11	+0·062	18	22–23	−0·040	31
11–12	+0·058	38	23–24	−0·054	33

By drawing a curve representing these mean differences in the usual way, and reading off from it for the beginning of each hour (noting that the mean of the groups of differences in R.A. arranged in order of N.P.D. given in the paper referred to above is $-0^{s}\cdot037$, and applying this with opposite sign to each $\Delta\alpha$) we have the final table of differences in R.A. depending on R.A.

R.A.	$\Delta\alpha_{\alpha}$ (1840–1850).	R.A.	$\Delta\alpha_{\alpha}$ (1840–1850).
h	s	h	s
0·0	−0·066	12·0	+0·054
1·0	−0·096	13·0	+0·031
2·0	−0·100	14·0	+0·025
3·0	−0·078	15·0	+0·018
4·0	−0·039	16·0	+0·009
5·0	−0·021	17·0	+0·008
6·0	−0·013	18·0	+0·019
7·0	−0·002	19·0	+0·021

R.A.	$\Delta\alpha_\alpha$ (1840–1850).	R.A.	$\Delta\alpha_\alpha$ (1840–1850).
h	s	h	s
8·0	+0·035	20·0	+0·023
9·0	+0·077	21·0	+0·021
10·0	+0·097	22·0	+0·012
11·0	+0·087	23·0	−0·024

For the N.P.D.s of these Catalogues, the differences have been formed by bringing up the places of the stars which are common to the Catalogues from the 1840 Catalogue, using the proper motions of the 1880 Catalogue, to 1850 and taking the differences, in the sense 1840–1850, between these and the N.P.D.s given in the 1850 Catalogue. These differences have then been arranged in order of N.P.D., and combined, generally, in groups extending each over 5°, and thus the following mean differences formed :—

N.P.D.	Mean $\Delta\delta$ 1840–1850.	Number of Stars.	N.P.D.	Mean $\Delta\delta$ 1840–1850.	Number of Stars.
° ′	″		° ′	″	
92·41	+0·63	13	137·54	−0·29	128
98·2	+0·63	15	141·55	−0·45	112
103·14	−0·22	25	147·43	−0·71	125
107·14	−0·45	60	152·26	−1·05	85
112·34	+0·02	79	157·39	−1·02	86
117·5	0·00	119	162·38	+0·27	33
122·7	−0·05	132	167·19	+0·19	28
127·24	−0·29	138	173·22	−0·04	12
132·37	−0·65	155			

The total number of stars used in this comparison is 1345. By drawing a reduction curve, in the usual way, and reading off from it, we have :—

N.P.D.	$\Delta\delta_\delta$ (1840–1850).	N.P.D.	$\Delta\delta_\delta$ (1840–1850.)
°	″	°	″
95	+0·54	135	−0·45
100	+0·25	140	−0·44
105	−0·19	145	−0·62
110	−0·20	150	−0·84
115	−0·04	155	−0·85
120	−0·04	160	−0·44
125	−0·19	165	+0·08
130	−0·37	170	+0·10

The differences of N.P.D. of these Catalogues, when arranged in order of R.A. and combined in groups extending each over one hour of R.A., are :—

R.A.	Mean Δδ 1840–1850.	Number of Stars.	R.A.	Mean Δδ 1840–1850.	Number of Stars.
h h	"		h h	"	
0–1	−0·29	28	12–13	−0·60	62
1–2	−0·41	40	13–14	−0·37	62
2–3	−0·46	40	14–15	−0·53	74
3–4	−0·38	69	15–16	−0·94	80
4–5	−0·17	68	16–17	−0·81	69
5–6	−0·07	83	17–18	−0·82	61
6–7	−0·04	99	18–19	−0·27	35
7–8	+0·13	98	19–20	−1·08	16
8–9	−0·28	91	20–21	−0·83	14
9–10	−0·35	64	21–22	−0·20	17
10–11	−0·52	73	22–23	−0·11	17
11–12	−0·53	67	23–24	+0·47	18

The reading of the reduction curve for the beginning of each hour of R.A. has been taken, and +0″·37 applied to each reading to correct for the mean discordance depending on N.P.D. We thus find the following table of discordances depending on R.A. :—

R.A.	$\Delta\delta_a$ (1840–1850).	R.A.	$\Delta\delta_a$ (1840–1850).
h	"	h	"
0·0	+0·37	12·0	−0·18
1·0	+0·13	13·0	−0·13
2·0	−0·07	14·0	−0·15
3·0	−0·05	15·0	−0·33
4·0	+0·09	16·0	−0·46
5·0	+0·24	17·0	−0·42
6·0	+0·33	18·0	−0·26
7·0	+0·36	19·0	−0·26
8·0	+0·28	20·0	−0·26
9·0	+0·08	21·0	−0·17
10·0	−0·07	22·0	+0·20
11·0	−0·15	23·0	+0·42

II. *The Cape Catalogues for* 1840 *and* 1860.

The comparison in N.P.D., when the stars are arranged in order of N.P.D., is given, for these two Catalogues, in *Monthly Notices*, vol. xli. pp. 150, 151.

The differences of R.A., deduced as for the preceding comparisons, arranged in order of N.P.D., and combined in groups extending each over 5° of N.P.D., give the following table :—

N.P.D.	Mean $\Delta\alpha$ 1840-1860.	Number of Stars.	N.P.D.	Mean $\Delta\alpha$ 1840-1860.	Number of Stars.
° ′	s		° ′	s	
39·0	−0·110	3	112·54	−0·016	18
55·4	−0·063	7	117·23	+0·006	48
62·5	+0·001	13	122·34	+0·036	49
68·25	−0·034	22	127·20	+0·024	40
71·56	+0·001	13	132·44	+0·018	56
77·19	−0·004	16	137·31	+0·052	33
82·32	+0·018	23	142·37	−0·009	31
87·9	+0·014	14	147·21	+0·005	32
91·47	+0·039	9	152·29	−0·013	29
98·5	−0·019	14	157·18	+0·015	30
102·30	−0·019	12	165·54	−0·070	20
107·36	+0·017	21	174·14	−0·030	20

The total number of stars used in this comparison is 573.

The reduction curve, constructed in the usual way, gives the following readings :—

N.P.D.	$\Delta\alpha_\delta$ (1840-1860).	N.P.D.	$\Delta\alpha_\delta$ (1840-1860).
°	s	°	°
65	−0·020	120	+0·017
70	−0·012	125	+0·026
75	−0·003	130	+0·027
80	+0·008	135	+0·028
85	+0·019	140	+0·020
90	+0·021	145	+0·002
95	+0·005	150	−0·003
100	−0·008	155	−0·008
105	−0·006	160	−0·023
110	−0·001	165	−0·035
115	+0·001	174·4	−0·030

The differences of R.A., arranged in order of R.A., and combined in groups extending each over one hour of R.A., give the following table :—

R.A.	Mean $\Delta\alpha$ 1840–1860.	Number of Stars.	R.A.	Mean $\Delta\alpha$ 1840–1860.	Number of Stars.
h h	s		h h	s	
0–1	−0·013	19	12–13	+0·039	23
1–2	+0·016	28	13–14	+0·093	19
2–3	−0·022	20	14–15	+0·059	20
3–4	−0·006	22	15–16	+0·007	37
4–5	−0·001	29	16–17	−0·008	25
5–6	−0·020	28	17–18	−0·053	35
6–7	+0·048	23	18–19	−0·017	33
7–8	+0·019	26	19–20	−0·044	20
8–9	+0·016	22	20–21	−0·048	21
9–10	+0·060	22	21–22	−0·014	18
10–11	+0·048	20	22–23	−0·025	23
11–12	+0·024	22	23–24	+0·028	18

Reading off from the reduction curve for the beginning of each hour of R.A., and applying $-0^{s}\cdot005$ to correct for the mean discordance in R.A. depending on N.P.D., we have :—

R.A.	$\Delta\alpha_a$ (1840–1860).	R.A.	$\Delta\alpha_a$ (1840–1860).
h	s	h	s
0·0	0·000	12·0	+0·036
1·0	−0·004	13·0	+0·053
2·0	−0·010	14·0	+0·055
3·0	−0·014	15·0	+0·031
4·0	−0·014	16·0	−0·005
5·0	−0·008	17·0	−0·030
6·0	+0·008	18·0	−0·038
7·0	+0·021	19·0	−0·042
8·0	+0·022	20·0	−0·044
9·0	+0·032	21·0	−0·037
10·0	+0·041	22·0	−0·023
11·0	+0·035	23·0	−0·006

The differences of the N.P.D.s of these two Catalogues when the stars are arranged in order of R.A. and combined in groups extending each over one hour of R.A. are :—

R.A.	Mean $\Delta\delta$ 1840–1860.	Number of Stars.	R.A.	Mean $\Delta\delta$ 1840–1860.	Number of Stars.
h h	"		h h	"	
0–1	−0·25	13	12–13	+0·12	13
1–2	+0·10	20	13–14	+0·35	17
2–3	−0·05	11	14–15	+0·46	13
3–4	−0·19	16	15–16	+0·08	24
4–5	+0·03	23	16–17	−0·23	17
5–6	−0·01	17	17–18	−0·11	21
6–7	+0·08	20	18–19	+0·04	16
7–8	+0·26	19	19–20	−0·13	12
8–9	−0·31	18	20–21	+0·02	9
9–10	−0·05	20	21–22	−0·04	14
10–11	−0·08	24	22–23	+0·10	16
11–12	+0·32	15	23–24	+0·06	13

Applying a correction of −0″·02 for mean discordance in N.P.D. depending upon N.P.D., the reduction curve gives :—

R.A.	$\Delta\delta_a$ (1840–1860).	R.A.	$\Delta\delta_a$ (1840–1860)
h	"	h	"
0·0	−0·07	12·0	+0·20
1·0	−0·07	13·0	+0·28
2·0	−0·05	14·0	+0·32
3·0	−0·10	15·0	−0·21
4·0	−0·10	16·0	−0·05
5·0	−0·03	17·0	−0·14
6·0	+0·06	18·0	−0·10
7·0	+0·07	19·0	−0·07
8·0	−0·05	20·0	−0·07
9·0	−0·15	21·0	−0·04
10·0	−0·10	22·0	+0·01
11·0	+0·09	23·0	0·00

III.—*The Cape Catalogues for* 1850 *and* 1880.

The comparison in R.A. of these two Catalogues, when the stars are arranged in order of N.P.D., is given in *Monthly Notices*, vol. xlv. pp. 298, 299. Using the materials on pp. viii. and ix. of the Introduction to the Cape Catalogue for 1850, where the stars are combined in order of R.A. in groups extending each over 4 hours of R.A., we have the following mean differences :—

R.A.		Mean $\Delta\alpha$ 1850–1880.	Number of Stars.	R.A.		Mean $\Delta\alpha$ 1850–1880.	Number of Stars.
h	m	s		h	m	s	
2	4	+0·049	541	14	19	+0·164	425
6	12	+0·119	673	17	50	+0·078	718
9	40	+0·110	535	21	59	+0·028	476

The correction for mean discordance in R.A. depending on N.P.D. is $-0^{s}\cdot090$, and applying this the reduction curve gives:

R.A.	$\Delta\alpha_a$ (1850–1880).	R.A.	$\Delta\alpha_a$ (1850–1880).
h	s	h	s
0·0	−0·055	12·0	+0·046
1·0	−0·050	13·0	+0·057
2·0	−0·042	14·0	+0·072
3·0	−0·021	15·0	+0·058
4·0	−0·002	16·0	+0·035
5·0	+0·014	17·0	+0·013
6·0	+0·028	18·0	−0·004
7·0	+0·027	19·0	−0·023
8·0	+0·025	20·0	−0·040
9·0	+0·022	21·0	−0·056
10·0	+0·022	22·0	−0·063
11·0	+0·033	23·0	−0·059

Again, making use of the materials given in the Introduction to the 1850 Catalogue, and combining the stars arranged in order of N.P.D. in groups of 6°, we have:—

N.P.D.		Mean $\Delta\delta$ 1850–1880.	Number of Stars.	N.P.D.		Mean $\Delta\delta$ 1850–1880.	Number of Stars
°	′	″		°	′	″	
92	55	−0·59	136	141	0	−0·59	328
98	51	−0·47	145	147	1	−0·80	338
104	58	−0·35	117	151	42	−0·35	292
112	5	−0·60	156	158	43	−0·38	193
116	51	−0·50	533	164	46	−0·97	73
122	37	−0·28	404	170	14	−0·65	59
129	4	−0·12	376	176	7	−0·07	5
134	55	−0·33	380				

The total number of stars used in this comparison is 3535. Reading off the differences of N.P.D. from the curve, drawn in the usual manner, gives the following table:—

N.P.D.	$\Delta\delta_\delta$ (1850–1880).	N.P.D.	$\Delta\delta_\delta$ (1850–1880).
°	″	°	″
95	−0·54	135	−0·33
100	−0·43	140	−0·54
105	−0·35	145	−0·69
110	−0·54	150	−0·55
115	−0·56	155	−0·38
120	−0·39	160	−0·44
125	−0·20	165	−0·57
130	−0·13	170	−0·74

From the data on page xiv. of the Introduction to the 1850 Catalogue, where the stars are combined in groups extending each over 4 hours of R.A., the following mean differences are found :—

R.A.		Mean Δδ 1850–1880.	Number of Stars.	R.A.		Mean Δδ 1850–1880.	Number of Stars.
h	m	″		h	m	″	
2	4	−0·29	491	14	19	−0·57	488
6	12	−0·10	635	17	50	−0·66	750
9	40	−0·24	639	21	59	−0·83	532

Reading off from the reduction curve, and applying + 0″·45 for mean discordance in N.P.D., when the stars are arranged in order of N.P.D. we have :—

R.A.	$\Delta\delta_\alpha$ (1850–1880).	R.A.	$\Delta\delta_\alpha$ (1850–1880).
h	″	h	″
0·0	−0·12	12·0	+0·05
1·0	0·00	13·0	−0·03
2·0	+0·15	14·0	−0·10
3·0	+0·20	15·0	−0·13
4·0	+0·26	16·0	−0·16
5·0	+0·31	17·0	−0·18
6·0	+0·34	18·0	−0·22
7·0	+0·33	19·0	−0·25
8·	+0·29	20·0	−0·30
9·0	+0·25	21·0	−0·35
10·0	+0·18	22·0	−0·38
11·0	+0·12	23·0	−0·27

IV.—*The Cape Catalogue for* 1860 *and the Melbourne Catalogue for* 1870.

The R.A.s of the stars which are common to these two Catalogues, as given in the 1860 Catalogue, have been brought up to 1870, using the proper motions of the Cape Catalogue for

1880, and the differences Cape 1860 *minus* Melbourne 1870 taken. These, when arranged in order of N.P.D. and combined in groups extending, generally, over 5° of N.P.D., give the following mean differences:—

N.P.D.	Mean $\Delta\alpha$ 1860–1870.	Number of Stars.	N.P.D.	Mean $\Delta\alpha$ 1860–1870.	Number of Stars.
° ′	s		° ′	s	
48 0	−0·050	5	117 32	−0·001	21
57 13	−0·023	3	122 24	−0·003	12
62 10	+0·005	10	128 6	−0·056	22
67 56	−0·001	9	132 35	−0·010	45
72 14	−0·017	7	137 17	−0·059	31
77 19	+0·022	13	142 52	−0·081	16
82 47	+0·014	13	147 41	−0·056	23
87 20	+0·023	11	152 17	−0·044	29
91 54	−0·013	11	157 18	−0·092	34
97 52	−0·013	8	162 14	−0·026	10
102 39	−0·010	5	167 40	+0·015	15
107 22	+0·022	9	172 11	+0·078	24
112 54	−0·016	8	176 45	+0·187	12

The total number of stars used in this comparison is 406. A curve representing these differences being drawn in the usual manner, the following table is found by reading off from it:—

N.P.D.	$\Delta\alpha_\delta$ (1860–1870).	N.P.D.	$\Delta\alpha_\delta$ (1860–1870).
°	s	°	s
52	−0·038	112	−0·003
56	−0·024	116	−0·005
60	−0·011	120	−0·012
64	−0·004	124	−0·022
68	−0·003	128	−0·032
72	−0·003	132	−0·035
76	+0·006	136	−0·048
80	+0·017	140	−0·063
84	+0·018	144	−0·069
88	+0·009	148	−0·059
92	−0·004	152	−0·058
96	−0·013	156	−0·063
100	−0·010	160	−0·050
104	0·000	164	−0·021
108	+0·004	168	+0·018

The differences in R.A. of these two Catalogues being arranged in order of R.A., and combined in groups extending each over one hour of R.A., give :—

R.A.	Mean $\Delta\alpha$ 1860–1870.	Number of Stars.	R.A.	Mean $\Delta\alpha$ 1860–1870.	Number of Stars.
h h	s		h h	s	
0–1	−0·020	15	12–13	−0·021	17
1–2	−0·031	20	13–14	−0·016	16
2–3	−0·033	12	14–15	−0·008	13
3–4	−0·071	13	15–16	−0·038	20
4–5	−0·056	19	16–17	−0·002	13
5–6	−0·030	17	17–18	+0·026	22
6–7	+0·039	12	18–19	+0·019	24
7–8	+0·012	17	19–20	−0·027	19
8–9	−0·068	20	20–21	−0·056	13
9–10	−0·040	19	21–22	−0·009	17
10–11	+0·041	23	22–23	+0·002	20
11–12	+0·042	10	23–24	−0·029	15

Reading off from the reduction curve for the beginning of each hour of R.A., and applying + 0^s·016 to each difference to correct for the mean discordance in R.A. when the stars are arranged in order of N.P.D., we have :—

R.A.	$\Delta\alpha_\alpha$ (1860–1870).	R.A.	$\Delta\alpha_\alpha$ (1860–1870).
h	s	h	s
0·0	−0·007	12·0	+0·028
1·0	−0·011	13·0	+0·005
2·0	−0·017	14·0	−0·002
3·0	−0·034	15·0	−0·005
4·0	−0·041	16·0	+0·002
5·0	−0·022	17·0	+0·025
6·0	+0·015	18·0	+0·033
7·0	+0·023	19·0	+0·011
8·0	−0·004	20·0	−0·017
9·0	−0·019	21·0	−0·014
10·0	+0·016	22·0	+0·005
11·0	+0·051	23·0	+0·004

The mean differences in N.P.D., for groups extending over 5° of N.P.D. arranged in order of N.P.D., have been taken from L. de Ball's paper "Untersuchungen über die eigene Bewegung des

Sonnensystems," page 2, and a reduction curve drawn, the readings from which are as follows:—

N.P.D.	$\Delta\delta_s$ (1860-1870).	N.P.D.	$\Delta\delta_s$ (1860-1870).
°	″	°	″
64	−0·17	120	+0·52
68	0·00	124	+0·43
72	+0·13	128	+0·42
76	+0·18	132	+0·51
80	+0·22	136	+0·63
84	+0·23	140	+0·65
88	+0·25	144	+0·68
92	+0·28	148	+0·70
96	+0·24	152	+0·70
100	+0·22	156	+0·62
104	+0·24	160	+0·55
108	+0·32	164	+0·47
112	+0·42	168	+0·37
116	+0·52		

The total number of stars used in this comparison is 388. The differences of N.P.D. when the stars are arranged in order of R.A. have been computed directly, and having been combined in groups extending each over one hour of R.A., there results:—

R.A.	Mean $\Delta\delta$ 1860-1870.	Number of Stars.	R.A.	Mean $\Delta\delta$ 1860-1870.	Number of Stars.
h h	″		h h	″	
0–1	+0·48	16	12–13	+0·69	17
1–2	+0·64	21	13–14	−0·04	16
2–3	+1·08	12	14–15	+0·44	13
3–4	+0·64	11	15–16	+0·38	20
4–5	+0·47	19	16–17	+0·10	13
5–6	+0·41	17	17–18	+0·40	22
6–7	+0·28	12	18–19	−0·02	24
7–8	+0·42	17	19–20	+0·10	19
8–9	+0·52	20	20–21	+0·23	14
9–10	+0·75	19	21–22	+0·38	17
10–11	+0·27	23	22–23	+0·65	20
11–12	+0·13	10	23–24	+0·64	15

The total number of stars used is in this case 407. Reading off from the curve and applying $-0''.41$ to correct for the mean discordance in N.P.D., when the stars are arranged in order of N.P.D., leads to the following table:—

R.A. h	$\Delta\delta_a$ (1860-1870).	R.A. h	$\Delta\delta_a$ (1860-1870).
0·0	+0″·16	12·0	−0″·07
1·0	+0·21	13·0	−0·09
2·0	+0·39	14·0	−0·14
3·0	+0·38	15·0	−0·08
4·0	+0·18	16·0	−0·13
5·0	+0·04	17·0	−0·18
6·0	−0·04	18·0	−0·24
7·0	−0·03	19·0	−0·29
8·0	+0·09	20·0	−0·24
9·0	+0·16	21·0	−0·09
10·0	+0·02	22·0	+0·11
11·0	−0·10	23·0	+0·20

V.—*The Melbourne Catalogue for* 1870 *and the Cape Catalogue for* 1880.

The comparison in R.A. of these two Catalogues, when the stars are arranged in order of N.P.D., is given in *Monthly Notices*, vol. xlv. pp. 300, 301, and the comparison in N.P.D., when the stars are arranged in the same order, in *Monthly Notices*, vol. xlii. pp. 20, 21. For the comparison in R.A., when the stars are arranged in order of R.A. and combined in groups extending each over one hour of R.A., we have:—

R.A. h h	Mean $\Delta\alpha$ 1870-1880. s	Number of Stars.	R.A. h h	Mean $\Delta\alpha$ 1870-1880. s	Number of Stars.
0–1	−0·021	38	12–13	−0·002	49
1–2	−0·002	37	13–14	+0·006	42
2–3	+0·034	18	14–15	+0·003	44
3–4	+0·126	33	15–16	−0·039	33
4–5	+0·027	30	16–17	−0·014	41
5–6	+0·026	40	17–18	−0·006	37
6–7	+0·013	29	18–19	+0·037	47
7–8	+0·067	42	19–20	+0·002	36
8–9	+0·090	50	20–21	+0·054	36
9–10	+0·043	41	21–22	−0·055	29
10–11	+0·073	42	22–23	+0·013	46
11–12	+0·007	34	23–24	−0·013	42

Reading off from the reduction curve for the beginning of each hour of R.A., and applying $-0^{s}\cdot021$ to correct for the mean discordance in R.A. depending on N.P.D., the following table is formed :—

R.A.	$\Delta\alpha_a$ (1870-1880).	R.A.	$\Delta\alpha_a$ (1870-1880).
h	s	h	s
0·0	−0·033	12·0	−0·003
1·0	−0·028	13·0	−0·017
2·0	+0·004	14·0	−0·023
3·0	+0·043	15·0	−0·036
4·0	+0·045	16·0	−0·042
5·0	+0·017	17·0	−0·029
6·0	+0·006	18·0	−0·010
7·0	+0·024	19·0	0·000
8·0	+0·046	20·0	−0·002
9·0	+0·047	21·0	−0·019
10·0	+0·035	22·0	−0·032
11·0	+0·015	23·0	−0·031

Proceeding in exactly the same way with the N.P.D.s arranged in order of R.A., we get the following mean differences :—

R.A.	Mean $\Delta\delta$ 1870-1880.	Number of Stars.	R.A.	Mean $\Delta\delta$ 1870-1880.	Number of Stars.
h h	″		h h	″	
0–1	−0·61	38	12–13	−0·04	50
1–2	−0·56	35	13–14	+0·01	43
2–3	−0·67	18	14–15	−0·57	43
3–4	−0·78	32	15–16	−0·19	33
4–5	−0·79	31	16–17	−0·46	40
5–6	−0·69	40	17–18	−0·47	36
6–7	−0·57	29	18–19	−0·31	48
7–8	−0·10	43	19–20	−0·69	36
8–9	−0·86	50	20–21	−0·52	36
9–10	−0·62	41	21–22	−0·75	29
10–11	−0·17	42	22–23	−0·67	46
11–12	−0·14	34	23–24	−0·86	42

Applying $+\ 0''\cdot50$ to correct for the mean discordance in N.P.D. depending on N.P.D., we have finally :—

R.A. h	$\Delta\delta_\alpha$ (1870–1880). "	R.A. h	$\Delta\delta_\alpha$ (1870–1880). "
0·0	−0·23	12·0	+0·40
1·0	−0·12	13·0	+0·42
2·0	−0·14	14·0	+0·26
3·0	−0·23	15·0	+0·15
4·0	−0·27	16·0	+0·13
5·0	−0·23	17·0	+0·08
6·0	−0·06	18·0	+0·06
7·0	+0·05	19·0	−0·01
8·0	−0·01	20·0	−0·10
9·0	−0·09	21·0	−0·16
10·0	+0·10	22·0	−0·20
11·0	+0·32	23·0	−0·25

Blackheath: May 13, 1886.

On the Proper Motion of Twenty-nine Telescopic Stars.

By J. L. E. Dreyer, Ph.D.

Of late years a considerable number of telescopic stars have been found to have Proper Motion. Not only has Argelander thoroughly investigated 480 stars, the great majority of which are below the sixth magnitude, and deduced the most probable values of their Proper Motions from all published observations of them, but every new Star Catalogue has added to the number of known Proper Motions, while not a few cases casually detected are to be found in the volumes of the *Astronomische Nachrichten*. I propose in this paper to discuss the Proper Motions of twenty-nine stars contained in the Second Armagh Catalogue of 3300 stars, as every contribution to our knowledge of one of the most important departments of Sidereal Astronomy must be of some value.

The Armagh Observations were made in the years 1859 to 1883 with the Mural Circle by Jones, to which in 1862 was added a telescope of seven inches' aperture by the late Mr. Th. Grubb. For further details as regards the instrument, the observations and their reduction, I may refer to the Catalogue itself, which I hope will be distributed in a few weeks. The working list was formed by selecting suitable stars from Baily's Lalande, which were supposed not to have been lately reobserved elsewhere. The mean places for 1875 resulting from the Armagh

Observations were compared with Baily's places, and wherever a difference appeared, exceeding upwards of a second of time in R.A. and eight or ten seconds in N.P.D., the voluminous list of corrections to Baily, given by Argelander in vol. vii. of the Bonn Observations, was in the first instance consulted. If this did not clear up the discrepancy, other modern Catalogues were examined in order to see whether the star was endowed with Proper Motion. In a great many cases it turned out that it was not, but whenever it seemed at all likely that there was Proper Motion, and that its amount had not been previously determined, all the materials available for this purpose were brought together. Lalande's observations were first reduced anew by means of Von Asten's excellent tables. The positions in Weisse's first Catalogue were also tested by a renewed reduction from the Königsberg Observations, but as the places found differed but very slightly from Weisse's, this precaution was not considered necessary in the case of Weisse's second Catalogue, as it is well known that it was prepared with considerably more care than the first one. All other modern Catalogues were searched and the positions were reduced to 1875, the epoch of the second Armagh Catalogue.

As the forthcoming Paris Catalogue, the Zone Catalogues of the *Astronomische Gesellschaft*, and probably also in some cases the new Brussels Catalogue, will soon furnish plenty of excellent positions for the stars in question, the Proper Motions in this paper are not to be considered as definitively determined. I have, therefore, simply used the places taken from the various Star Catalogues without applying systematic corrections for difference of equinox, &c. This omission can, however, hardly influence the results much, as the latter must for many years to come to a great extent depend on Bessel's and Lalande's observations; and considering the long interval of time which separates us from these, the systematic corrections to them become of less consequence. Whenever a star occurred in more than two Catalogues, in addition to the new Armagh Catalogue, the Proper Motion in both co-ordinates was computed by the method of least squares.

In the following the stars are designated by their numbers in the new Catalogue and in Baily's Lalande. For all stars north of 92° N.P.D. the magnitudes are taken from the *Durchmusterung*. The places are for 1875·0. Figures in brackets denote the number of observations; except where otherwise stated, each result depends only on one observation.

448 = LL. 6638, Mag. 8·0.

		h m s		° ′ ″
Lalande	1798·00	3 29 38·33	1798·00	64 24 34·6
Bessel	1828·10	39·11	1828·10	47·0
Armagh	1873·70	39·93 (4)	1874·29	54·9 (3)

Applying a Proper Motion = + 0ˢ·019 and + 0″·22 we get:

	h	m	s	°	′	″
Lalande	3	29	39·79	64	24	51·5
Bessel			40·00			57·3
Armagh			39·95			55·1

462 = LL. 6938, Mag. 7·0.

		h	m	s		°	′	″
Lalande	1799·88	3	38	15·27	1799·88	109	30	59·1
Arg. Oeltzen	1850·92			16·16	1850·92			59·5
Armagh	1871·96			16·74	1865·95			48·9 (2)

The two Armagh results in N.P.D. agree well *inter se*. It must be left for the future to decide whether there is P.M. in this co-ordinate. Applying a P.M. = + 0ˢ·024 we get:

	h	m	s
Lalande	3	38	17·07
Argelander			16·74
Armagh			16·81

521 = LL. 7892, Mag. 7·0.

		h	m	s		°	′	″
Lalande	1798·05	4	7	16·96	1798·05	77	58	4·2
Bessel	1823·01			18·17	1823·01			8·0
Rümker	1847·0			18·51 (2)	1847·0			8·4 (2)
Glasgow	1872·39			19·12 (2)	1874·29			11·6 (3)
Armagh	1876·20			19·35 (4)	1876·91			10·5 (5)

Giving the two last positions double weight we find P.M. = + 0ˢ·0270 and + 0″·080. Applying these we get:

	h	m	s	°	′	″
Lalande	4	7	19·04	77	58	10·4
Bessel			19·57			12·2
Rümker			19·27			10·6
Glasgow			19·19			11·7
Armagh			19·32			10·3

624 = LL. 9491, Mag. 7·0.

		h	m	s		°	′	″
Lalande	1799·88	4	55	54·67	1799·88	101	7	2·8
Bessel	1824·53			54·84 (2)	1824·53			8·0 (2)
Santini	1843·0			54·90	1843·0			7·7
Santini	1857·0			55·21	1857·0			1·4
Armagh	1879·02			55·23	1880·48			5·2 (2)

Bessel's single results in N.P.D. are 10″·8 and 5″·2. There is probably no P.M. in N.P.D. Giving all the Right Ascensions equal weight we find P.M. = + 0ˢ·0072, which gives:

	h	m	s
Lalande	4	55	55·21
Bessel			55·20
Santini			55·13
Santini			55·34
Armagh			55·20

677 = LL. 10394, Mag. 7·0.

		h	m	s		°	′	″
Lalande	1798·06	5	25	3·62	1798·06	100	9	34·9
Bessel	1823·96			[3·08]	1823·96			47·0
Santini	1843·0			3·65 (2)	1843·0			52·9 (2)
Santini	1857·0			4·03 (2)	1857·0			54·9 (2)
Armagh				—	1860·00			55·4 (2)
Armagh	1873·96			4·14 (3)	1875·95			63·4 (4)

Rejecting Bessel's R.A. and giving all the others equal weight the P.M. is found = + 0ˢ·0081 and + 0″·354, which gives:

	h	m	s	°	′	″
Lalande	5	25	4·24	100	10	2·1
Bessel			-			5·1
Santini			3·91			4·2
Santini			4·17			1·3
Armagh			—			0·7
Armagh			4·15			2·9

In N.P.D. the Proper Motion is well established, in R.A. it is somewhat doubtful. Lalande's R.A. depends, however, on two wire-transits agreeing well *inter se*.

729 = LL. 11196, Mag. 7·0.

		h	m	s		°	′	″
Lalande	1798·06	5	48	51·97	1798·06	76	4	11·3
Bessel	1823·18			53·07	1823·18			27·1
Glasgow	1867·15			54·55	1867·15			51·8
Armagh	1871·11			54·70 (2)	1871·11			52·9 (2)
Glasgow	1877·05			54·64	1878·88			54·3 (2)
Armagh	1881·50			55·06 (2)	1881·65			56·9 (3)

As the Glasgow and Armagh observations are made at two epochs differing about ten years, I have used them separately. Giving the above positions equal weight the P.M. is found = + 0ˢ.0341 and + 0″·540. Applying these to the observations we have:

		h m s	° ′ ″
Lalande		5 48 54·59	76 4 52·8
Bessel		54·84	55·1
Glasgow	1867	54·82	56·0
Armagh	1871	54·83	55·0
Glasgow	1877–78	54·71	52·2
Armagh	1881	54·84	53·3

788 = LL. 12293–96, Mag. 7·4.

		h m s		° ′ ″
Lalande	1797·11	6 20 23·90 (2)	1797·11	53 25 57·8 (2)
Bessel	1829·20	23·45	1829·20	26 6·2
Armagh	1869·89	21·90 (5)	1866·73	26 13·4 (6)

Applying a P.M. of $-$ 0^s·031 and $+$ 0″·21 we get:

	h m s	° ′ ″
Lalande	6 20 21·49	53 26 14·2
Bessel	22·03	15·8
Armagh	21·74	15·1

985 = LL. 16494, Mag. 7·5.

		h m s	° ′ ″
Lalande	1794·11	8 18 9·90	90 44 0·8
Bessel	1824·05	10·33	14·4
Santini	1839·0	10·51	14·1
Lamont	1841·59	10·59 (10)	12·4 (10
Santini	1862·0	10·74	21·6
Göttingen	1868·65	10·62 (2)	20·0 (2)
Armagh	1879·18	10·95 (2)	21·8 (2)

Giving Lamont, Göttingen, and Armagh double weight, the P.M. is found $=$ $+$ 0^s·0098 and $+$ 0″·228. Applying this we get:

	h m s	° ′ ″
Lalande	8 18 10·69	90 44 19·2
Bessel	10·83	26·0
Santini	10·86	22·3
Lamont	10·92	20·0
Santini	10·87	24·0
Göttingen	10·68	21·4
Armagh	10·91	20·9

1010 = LL. 16964, Mag. 6·5.

		h m s	° ′ ″
Lalande	1796·18	8 31 24·43	68 52 10·3
Bessel	1826·13	24·12	17·9
Armagh	1880·21	24·05	27·0

Assuming a P.M. = − 0ˢ·003 and + 0″·18 these positions become:

	h	m	s	°	′	″
Lalande	8	31	24·19	68	52	23·5
Bessel			23·97			26·7
Armagh			24·07			26·1

The P.M. is somewhat doubtful, especially in R.A., as Lalande has only one wire and gives no fraction of the second.

1294 = LL. 21358, Mag. 8·0.

		h	m	s		°	′	″
Lalande	1798·19	11	3	17·97	1798·19	86	52	3·8
Bessel	1823·28			17·36	1823·28			8·1
Lamont	1842·29			17·31	1842·29			2·7
Armagh	1851·28			16·96	1854·23			4·9 (2)
Schjellerup	1862·19			16·83	1862·19			3·8
Glasgow	1868·89			16·67 (3)	1868·89			6·3 (3)
Armagh	1883·26			16·53	1883·26			10·8

There seems to be no Proper Motion in N.P.D. Giving the Glasgow R.A. double weight, the P.M. is found = − 0ˢ·0172, applying which we get:

	h	m	s
Lalande	11	3	16·65
Bessel			16·47
Lamont			16·75
Armagh			16·55
Schjellerup			16·61
Glasgow			16·57
Armagh			16·67

1462 = LL. 23640, Mag. 7·2.

		h	m	s		°	′	″
Lalande	1791·25	12	32	37·77	1791·25	44	5	29·1
Arg. Oeltzen	1843·36			37·22	1843·36			37·6
Radcliffe	1851·8			37·14 (4)	1851·7			38·2 (5)
Armagh	1876·32			36·53 (2)	1868·34			37·1 (2)

It does not seem likely that there is Proper Motion in N.P.D. The amount of P.M. in R.A. depends to a great extent on the weight which is given to Lalande, and as he has only one wire and no fraction of the second, his R.A. may possibly be too small. Giving LL. weight = ½ and Glasgow and Radcliffe 2, the P.M. becomes = − 0ˢ·0178, applying which we get:

		h	m	s				
Lalande		12	32	36·28				
Argelander				36·66				
Radcliffe				36·73				
Armagh				36·55				

1554 = LL. 24760–61, Mag. 7·2.

		h	m	s		°	′	″	
Lalande	1796·28	13	14	27·84 (2)		51	10	44·9	(2)
Armagh	1875·37			25·42				53·6	

This star does not occur in any other Catalogue. The P.M. must be nearly $-$ 0^s·031 and + 0″·11.

1727 = LL. 27055–56, Mag. 5·8.

		h	m	s		°	′	″	
Lalande	1794·85	14	44	39·15 (2)		65	34	15·4	(2)
Bessel	1826·41			39·70				20·6	
Armagh	1869·31			40·48				14·0	

With a P.M. = + 0^s·018 the Right Ascensions become:

	h	m	s
Lalande	14	44	40·59
Bessel			40·57
Armagh			40·58

1783 = LL. 27957, Mag. 6·5

		h	m	s			°	′	″	
Lalande	1798·44	15	14	21·82	1798·44		91	56	58·5	
Lamont	1851·87			20·74 (7)	1851·27			57	10·0	(6)
Göttingen	1868·27			20·40 (2)	1868·27				14·2	(2)
Armagh	1879·63			20·14 (4)	1879·63				17·1	(4)

Giving Lalande half weight the P.M. is found = $-$ 0^s·0222 and + 0″·265, which gives:

	h	m	s		°	′	″
Lalande	15	14	20·12		91	57	18·8
Lamont			20·23				16·3
Göttingen			20·25				16·0
Armagh			20·24				15·9

1880 = LL. 29259, Mag. 7·9.

		h	m	s			°	′	″	
Lalande	1798·32	15	58	17·06	1798·32		90	48	46·2	
Lamont	1852·67			16·26 (11)	1852·67				51·9	(11)
Göttingen	1867·85			15·96 (2)	1867·85				54·6	(2)
Armagh	1875·38			15·94 (3)	1880·34				57·3	(2)

Giving Lalande half weight we find P.M. = − 0ˢ·0142 and + 0″·138, applying which the positions become:

		h m s	° ′ ″
Lalande		15 58 15·97	90 48 56·7
Lamont		15·94	55·0
Göttingen		15·86	55·6
Armagh		15·94	56·6

1912 = LL. 29752, Mag. 7·2.

		h m s	° ′ ″
Lalande	1794·33	16 12 52·85	57 54 22·7
Bessel	1826·44	53·12 (2)	14·2 (2)
Armagh	1877·98	53·73 (2)	53 57·2 (2)

Applying a P.M. = + 0ˢ·011 and − 0″·34 we get:

		h m s	° ′ ″
Lalande		16 12 53·74	57 53 55·3
Bessel		53·65	57·7
Armagh		53·70	56·2

1949 = LL. 30271, Mag. 7·2.

		h m s	° ′ ″
Lalande	1794·33	16 31 35·36	58 46 34·0
Bessel	1826·44	35·43	50·2
Armagh	1876·06	35·47 (5)	47 13·6 (5)

There is probably no P.M. in R.A. In N.P.D. it is = + 0″·48, which gives:

	° ′ ″
Lalande	58 47 12·7
Bessel	13·5
Armagh	13·1

2355 = LL. 35851, Mag. 5·5.

		h m s	° ′ ″
Lalande	1794·44	19 2 20·09	73 19 25·6
Rümker	1838·0	20·79 (4)	41·5 (4)
Armagh	1876·61	20·91 (8)	54·4 (8)

With a P.M. = + 0ˢ·005 and + 0″·34 we get:

	h m s	° ′ ″
Lalande	19 2 20·49	73 19 53·0
Rümker	20·97	54·1
Armagh	20·90	53·9

In R.A. the Proper Motion is very doubtful, as Lalande has only one wire, but in N.P.D. it seems well established.

2684 = LL. 39934, Mag. 7·0.

		h m s		° ′ ″
Lalande	1793·59	20 33 55·28		51 47 33·3
Bessel	1825·70	56·46		40·5
Armagh	1876·24	56·68 (5)		48·9 (5)

As Lalande has only one wire and no fraction of the second, it is as yet impossible to decide whether there is any P.M. in R.A. In N.P.D. a P.M. of + 0″·17 gives:

	° ′ ″
Lalande	51 47 47·1
Bessel	48·9
Armagh	48·7

2732 = LL. 40484, Mag. 7·7.

		h m s		° ′ ″
Lalande	1794·50	20 50 26·72	1794·50	88 44 58·8
Piazzi	1802·68	26·55 (6)	1802·68	45 7·4 (6)
Bessel	1821·63	[27·58]	1821·63	6·4
Taylor	1837·0	26·55 (2)	1837·0	13·7 (2)
Lamont	1849·20	26·44 (13)	1849·20	17·1 (13)
Armagh	1865·66	26·38	1867·57	20·5

Bessel's R.A. is doubtless 1ˢ·0 too great; it has not been used. Giving Taylor's position weight 2 and Lamont's weight 3, the P.M. is found = − 0ˢ·0041 and + 0″·264, which gives:

	h m s	° ′ ″
Lalande	20 50 26·39	88 45 20·1
Piazzi	26·25	26·5
Bessel	26·36	20·5
Taylor	26·39	23·7
Lamont	26·33	23·9
Armagh	26·34	22·5

2741 = LL. 40604–6, Mag. 7·8.

		h m s		° ′ ″
Lalande	1794·14	20 52 11·42 (2)	1794·14	47 35 48·8 (2)
Bessel	1825·76	11·73	1825·76	45·5
Armagh	1871·67	12·65 (4)	1871·66	33·5 (3)

Adopting a P.M. = + 0^{s}·175 and − 0″·23 we get:

		h	m	s		°	′	″
Lalande		20	52	12·83		47	35	30·2
Bessel				12·59				34·2
Armagh				12·71				32·7

2835 = LL. 41700, Mag. 8.5.

		h	m	s		°	′	″
Lalande	1794·61	21	20	25·88	1794·61	85	5	0·7
Bessel	1821·66			26·69	1821·66			10·1
Lamont	1841·64			26·77	1841·64			14·6
Armagh	1874·24			26·79 (2)	1873·74			24·8

Lalande has only one wire and no fraction of the second. There can hardly be any Proper Motion in R.A. The observations of N.P.D. give a P.M. = + 0″·297, applying which we get:

	°	′	″
Lalande	85	5	24·6
Bessel			25·9
Lamont			24·5
Armagh			25·2

2883 = LL. 42286, Mag. 7·1.

		h	m	s		°	′	″
Lalande	1793·64	21	35	25·05		63	48	40·3
Bessel	1825·66			25·59				48·3
Armagh	1877·78			27·05 (4)				50·1 (4)

Adopting a P.M. of + 0^{s}·026, the Right Ascensions become:

	h	m	s
Lalande	21	35	27·16
Bessel			26·87
Armagh			26·98

Lalande has two wires, but they differ by 0^{s}·6. Still, the P.M. in R.A. seems certain. Lalande is probably 10″ wrong in P.D.

2933 = LL. 42843–44, Mag. 7·2.

		h	m	s		°	′	″
Lalande	1794·61	21	52	13·06 (2)	1794·61	86	48	38·6 (2)
Bessel	1821·66			12·77	1821·66			42 6
Santini	1839·0			12·21 (2)	1839·0			46·5 (2)
Lamont	1847·78			12·03	1847·78			42·7
Glasgow	1870·80			11·52 (3)	1870·80			51·4 (3)
Armagh	1875·17			11·56 (4)	1875·68			52·3 (5)

From these we find the P.M. = − 0ˢ·0202 and + 0″·179, which gives:

	h	m	s	°	′	″
Lalande	21	52	11·44	86	48	53·0
Bessel			11·69			52·1
Santini			11·48			52·9
Lamont			11·48			47·6
Glasgow			11·44			52·2
Armagh			11·56			52·2

3064 = LL. 44458–59, Mag. 7·5.

		h	m	s		°	′	″
Lalande	1794·61	22	37	27·82 (2)	1794·61	86	47	12·4 (2)
Bessel	1821·73			28·54 (2)	1821·73			5·4 (2)
Yarnall	1858·8			28·59 (2)	1853·9		46	51·5 (2)
Schjellerup	1861·97			28·54	1861·97			51·6
Glasgow	1871·70			28·72 (2)	1874·80			45·4 (4)
Armagh	1874·72			28·80 (5)	1874·72			47·1 (5)

Giving all equal weight, the P.M. is found = + 0ˢ·0104 and − 0″·329, which gives:

	h	m	s	°	′	″
Lalande	22	37	28·60	86	46	46·0
Bessel			29·09			47·9
Yarnall			28·76			44·6
Schjellerup			28·68			47·3
Glasgow			28·75			45·3
Armagh			28·80			47·

Bessel's observations were made on October 21 and September 1, 1821; the R.A.s differ by 0ˢ·33. If the second observation were left out, the agreement would be a little better in R.A.

3083 = LL. 44738, Mag. 7·2.

		h	m	s	°	′	″
Lalande	1797·74	22	45	24·30	38	36	36·4
Argelander	1842·45			25·34 (3)			29·5 (3)
Armagh	1878·91			25·44			21·2

Lalande has only one wire and no fraction of second; his R.A. is therefore probably 1ˢ·0 too small, and there would then be no P.M. in R.A. In N.P.D. a P.M. = − 0″·21 represents the observations as follows:

	°	′	″
Lalande	38	36	20·2
Argelander			22·7
Armagh			22·

3111 = LL. 45028, Mag. 7·9.

		h m s		° ′ ″
Lalande	1795·69	22 55 18·47	1795·69	94 30 23·0
Yarnall	1865·80	20·55 (7)	1865·70	43·3 (3)
Dunsink	1881·75	21·16 (3)	1881·75	47·0 (3)
Armagh	1883·93	21·01	1883·93	49·9

Giving the first and the last result half weight, the P.M. is found = + 0ˢ·0307 and + 0″·278, which gives:

	h m s	° ′ ″
Lalande	22 55 20·90	94 30 45·0
Yarnall	20·83	45·9
Dunsink	20·95	45·1
Armagh	20·74	47·4

3163 = LL. 45680, Mag. 7·5.

		h m s		° ′ ″
Lalande	1795·69	23 13 45·47	1795·69	94 35 44·1
Bessel	1822·73	45·96	1822·73	53·0
Santini	1843·0	46·22	1843·0	[64·5]
Armagh	1853·86	46·66	1850·70	59·2
Yarnall	1858·70	46·41 (3)	1861·80	56·4 (3)
Schjellerup	1862·95	46·74	1862·95	55·3
Glasgow	1868·80	46·62 (3)	1870·15	57·3 (3)
Armagh	1882·79	46·89	1882·79	59·0

Santini is doubtless 10″·0 wrong in P.D. Leaving this out, the P.M. is found = + 0ˢ·0163 + 0″·140, which gives (after correcting Santini by − 10″):

	h m s	° ′ ″
Lalande	23 13 46·76	94 35 55·2
Bessel	46·81	60·3
Santini	46·74	59·0
Armagh	47·00	62·6
Yarnall	46·68	58·6
Schjellerup	46·94	57·0
Glasgow	46·72	58·0
Armagh	46·76	57·9

3218 = LL. 46343–44–45, Mag. 6·8.

		h m s		° ′ ″
Lalande	1796·47	23 33 11·13 (3)	1796·47	62 27 28·8 (3)
Bessel	1827·75	12·10	1827·75	23·9
Armagh	1868·89	12·75	1867·80	13·0 (2)

Adopting a P.M. = + $0^{s}\cdot020$ and − $0''\cdot24$ we get:—

	h	m	s	°	′	″
Lalande	23	33	12·70	62	27	10·0
Bessel			13·04			12·6
Armagh			12·87			11·3

In addition to these Proper Motions, a number of other more doubtful cases have been found, which are mentioned in the Notes to the new Armagh Catalogue. These are: LL. 4381, 6106, 6254, 6275, 8618, 11374, 14264, 35817, 37766, 44738. These, as well as several stars with Proper Motion announced on a former occasion (*Copernicus*, vol. ii. pp. 148–151) I would recommend to the attention of meridian observers.

Micrometric Observations of Nova Andromedæ, made at the Observatory, Dunsink. By Sir R. S. Ball.

I see that Professor Asaph Hall has made a series of measures to try if *Nova Andromedæ* has an appreciable Parallax. Perhaps it may be of interest in connection with this subject to publish the following measurements which I made here last autumn with the South Equatorial. The instrument and mode of observing have been described in the various parts of the "Dunsink Observations."

From *Nova Andromedæ* to Star, 11th mag. *s.f.*

	Dist.	Pos.		Dist.	Pos.
1885.	″	° ′	1885.	′	° ′
30 Sep.	229·7	156 33	1 Dec.	228·3	155 35
3 Oct.	230·2	156 25	2 „	229·5	157 3
4 Nov.		156 17	9 „	229·4	156 36
30 „	228·8	155 29			

From *Nova Andromedæ* to Star, 10th mag. *p.*

	Dist.	Pos.		Dist.	Pos.
1885.	″	° ′	1885.	″	° ′
21 Sep.	110·0	262 0	30 Nov.	109·5	260 36
30 „	110·6	261 6	1 Dec.	109·7	261 22
3 Oct.	108·9	261 46	2 „	108·7	262 7
27 „	109·0	262 41	7 „	109·8	260 47
28 „	109·8	263 19	8 „	109·1	261 13
4 Nov.	109·9	262 17	9 „	108·3	261 35

Dunsink Observatory,
1886, *May* 13.

Observations of the New Star in Orion. By J. E. Gore.

The following are all my observations of this star since January 16, the last observation given in my paper in the *Monthly Notices* for January 1886. The comparison stars are as follows, and their magnitudes were measured for me by Professor Pickering with the meridian photometer at Harvard Observatory:

	Mag.
57 Orionis	5·90
(*b*) = Lalande 11088	6·09
(*c*) = D.M. + 20°, 1156	6·57

Observations of Nova Orionis.

Date of Observation.	Estimated Magnitude.	Notes.
1886, Jan. 23	7·5	Moonlight.
Jan. 29	8·3	More than one magnitude less than (*c*); no moon.
Feb. 3	8·5	Clear moonless sky. *Nova* about equal to a small star nearly due north of it.
Feb. 10	8¾	Small with binocular; moonlight.
Feb. 19	8¾	Faint with binocular; moon rising, 6·55 P.M.
Feb. 22	8·9	Faint with binocular; clear moonless sky.
Mar. 3	9	Faint with binocular; clear moonless sky.
Mar. 6	—	Only seen by glimpses with binocular; clear sky; no moon, 9·25 P.M.
Mar. 25	—	Glimpsed at intervals with binocular; very clear sky; no moon.
April 7	—	Only doubtfully glimpsed with binocular; very clear sky; moon setting.
April 28	—	*Nova* not visible with binocular; very clear sky.

The above observations were made with the binocular with which the star was discovered. From a comparison of the sky with Argelander's magnitudes, I find that the *minimum visible* of this binocular in a clear moonless sky is 8·9 or 9·0 mag. in the scale of the *Durchmusterung*, so that on March 6 the star could not have been much, if anything, brighter than 9·0 mag. My observations, therefore, show a diminution of light from December 13 to March 6 of about 3 magnitudes. Professor Pritchard finds a decrease of only half a magnitude to March 10 (*Monthly Notices*, March, 1886). Mr. Gemmill, on February 24, estimated the star as 9½ magnitude with 3¼-inch refractor (*English Mechanic*, April 16, 1886), and in a letter from a well-known observer in America, dated February 5, 1886, he estimated the *Nova* about 8 magnitude at that date. My observations have also been confirmed by Mr. H. M. Parkhurst, of New York, and by photometric observations at Harvard Observatory.

Ballysodare, Co. Sligo:
May 4, 1886.

Observations of the Companion of Sirius made at the Dearborn Observatory, Chicago, U.S.A. By Prof. G. W. Hough, Director.

(*Communicated by the Secretaries.*)

Date.	P.	S.
1886·066	28°·7	7″·31
·096	29·5	7·25
·099	28·8	7·10
·125	29·1	7·14
·128	28·7	7·21
·145	28·9	7·11
·164	28·8	7·23
·167	28·1	7·20
·170	28·2	7·22
·175	28·3	7·17
·186	29·0	7·25
·203	28·5	7·31
Mean Results 1886·144	28·7	7·21 (12 obs.)

Note on a remarkable Sun-spot. By B. J. Hopkins.

While examining the Sun's surface on April 24 at $20^h\ 55^m$, I had the good fortune to observe the somewhat rare phenomenon of a coloured sun-spot. At the time there were in all five spots on the solar disc, arranged in two groups; the largest spot being the one presenting the abnormal appearance, which in size was equal to all the others put together, and comprised within its single penumbra four distinct umbræ.

Coloured spots have been occasionally seen by different observers, but this spot differed from those hitherto observed, in that it was only two out of its four umbræ which presented an appearance different to what is usually seen. Observed with a three-inch refractor and an Huyghenian eye-piece magnifying fifty diameters, the spot referred to presented the extraordinary spectacle of being of two colours, its two southern umbræ being of the ordinary blackish hue, while the two northern umbræ were of a reddish-brown. So marked, indeed, was the colour, that never having seen such a phenomenon before—though I have observed several scores of spots in the course of the last ten years—I was at first inclined to attribute the unusual appearance to some defect in the instrument, or to some temporary imperfection of my sight. I therefore changed the eye-piece I was using for another negative of double the power, with the result that the only difference observable besides the in-

creased magnification was that one of the umbræ was more decidedly coloured than its companion.

Still the appearance was to me so unusual that I remained half inclined to doubt the evidence of my senses, and regard it as merely an optical illusion. To decide the question I called my wife, who upon looking through the telescope immediately remarked the colour of the spot, comparing it to that of rusty iron.

How long before I began observing, the spot had presented this abnormal appearance I am unfortunately unable to say; but by $21^h\ 15^m$, or twenty minutes after I first looked at the Sun, all trace of the unusual colour had vanished. I may say in conclusion that the penumbra of the spot presented nothing unusual in its appearance; it was only the umbra that was coloured.

Forest Gate, E.

Jupiter's Third Satellite in Transit, April 11, 1886.

By W. F. Denning.

The satellite crossed the planet as a dusky spot, except when near the limbs, where it was visible as a bright spot. The following notes were made during the progress of the phenomenon. The times are only approximate:—

$9^h\ 33^m$ Sat. III. increasing in faintness and drawing very close to the N.E. limb. It seems slightly overshadowed, especially on the side nearest *Jupiter*, where the shading reminds one of the penumbra falling on the Moon prior to a lunar eclipse.

9 49. III. in contact with exterior edge of disc, the satellite is much brighter than the planet's limb, though itself involved in a delicate veil of shade.

9 58. Ingress complete. Satellite growing perceptibly fainter though still far brighter than the limb, on which it is projected as a bold, pearl-like spot just within the periphery.

10 7. III. now quite invisible. It rapidly lost brightness until its tone became indistinguishable from that of the surface. The satellite is evidently in course of transition from a bright to a dark spot. The seeing not very good.

10 48. Light cirrous clouds partly hindered close observation until this time, then III. was immediately seen as a pale dusky spot, rather small, and traversing a bright zone separating two dark belts in the planet's north temperate zone, and lying midway between the N. equatorial belt and N. limb. The S. side of the satellite is evidently darker than the opposite side.

10 55. The satellite assuming a deeper tone. The air has now become steadier; definition very sharp.

As III. reached mid-transit it became still more obvious, and seemed elongated S.S.E. to N.N.W. The satellite was of a light brown colour, and not nearly so dark as I have seen it when the chord traversed has been nearer the equator.

During the later phases of the occurrence the seeing became very fine, and the complex details of the markings came out very numerously and distinct. The N. equatorial belt showed a large white spot interrupting its continuity. This was central at $11^h\ 14^m$, and immediately following it there was a great thickening of the belt, extending itself far to the eastwards. This belt was divided lengthwise by a narrow bright line. At times, when a perfectly steady image impressed itself on the eye, a large extent of the N. polar region was observed furrowed with narrow dark belts. They were parallel in direction, though not equidistant from each other or of the same relative distinctness. Close to the pole their distinctive outlines were lost in a confused shading.

The double belt N. of the great N. belt was broad and somewhat faint, with decided condensations here and there. As to the great S. belt its equatorial borders were literally studded by bright spots with intervening and somewhat ill-defined dark patches. From the latter there were delicate wisps of dark-grey matter running to the N.E. and commingling with a delicate, undulating belt at the equator. These dusky markings on the S. side of the equator nearly always trend in this direction, as if their material were evolved from the belt, and in flowing to lower ground at the equator deviated to the E. by the effects of the rapid axial rotation which carries this part of the surface over 458 miles per minute.*

At $11^h\ 54^m$ the shadow of Satellite III. had entered well upon the N.E. limb, and the contrast with the satellite itself, now between the central meridian and N.W. limb, was most marked. The shadow was much larger and jet black, like an ink spot on white paper. One might readily imagine the appearance due to a perforation in the planet through which the dark depths of the sky beyond could be seen. The satellite, though still perceptible as a dusky spot of increasing faintness, was very inconspicuous compared with the remarkably bold aspect of its shadow.

Bristol: April 19, 1886.

* I deduce this rate from the rotation of the equatorial white spot = 590·2 minutes, and adopting the equatorial diameter of Jupiter as 86,000 miles.

Meteor Shower of Halley's Comet. By W. F. Denning.

There is perhaps no star-shower which has, in recent years, stood so much in need of re-observation as the brilliant display of Aquariads discovered by Lieut.-Col. Tupman while cruising off the east coast of Sicily on the mornings of May 1 and 3, 1870. But the radiant point at 325°–2½°, 5° preceding *α Aquarii*, as determined on that occasion, does not rise in our latitude until just before daylight, so that the only prospect of recovering the shower was by morning watches, necessarily rendered very brief and imperfect by the prevailing twilight of the season. These circumstances enabled the shower to elude subsequent observation.

Heis had recorded that on May 2, 1848, he observed many falling stars with bright streaks ("viele Sternschnuppen mit hellen Schweifen"), but it is extremely uncertain whether this relates to a veritable pre-apparition of the special shower witnessed by Col. Tupman.

Observing just before daylight on May 4, 1878, Mr. Corder registered three meteors of this stream. He describes them as notable for great length of path, and found the radiant at 334°–1° (*Observatory*, vol. ii. p. 103). A few other paths observed by him at various times afterwards led him to place the centre at 334°–5°, April–May (*Monthly Notices*, xi. p. 135).

Contemporary with Col. Tupman's observations in 1870, a number of diligent observers were recording meteors in the clear Italian sky, and the materials they accumulated were published at Milan in 1882. I projected 229 paths given in this Catalogue for the interval April 29—May 6, between 13^h and $15\frac{1}{2}^h$, and found that about forty-five of these belonged to the display of Aquariads. The meteors were very bright, with streaks and singularly long trajectories, and their radiant point was indicated at about 335°–9° (*Monthly Notices*, xliii. p. 111–14). This value exhibited such a large discordance with that determined by Col. Tupman that it became more than ever necessary to secure new observations. This was rendered all the more imperative from the suggestive resemblance in date and place of the meteor shower with the computed radiant for Halley's comet (1835, iii.) at its nearest appulse to the earth's orbit on May 4, twelve days preceding its passage through the descending node. Prof. Herschel gives the point 337° ± 0°, May 4, as the theoretical radiant of meteoric particles from this comet (*B.A. Report on Luminous Meteors*, 1874, p. 349), and points out that the agreement with Col. Tupman's shower of 1870 is a significant one, notwithstanding the difference of 10° or 12° in their radiant points.

At the return of this shower in the present year we had a succession of very clear nights, and (the moon being absent) I obtained observations on April 25, 26, 27, 30, May 1, 3, 4, 5, 6, 8 and 9: 117 shooting stars were recorded in watches extending

over 27½ hours. On the whole, I found meteors extremely rare, the horary rate being about four. On May 3, though the atmosphere was highly transparent and the stars unusually brilliant during the five hours I continued to watch, only twenty-one were seen. Again, on May 5, not more than twenty-four were counted in four hours. I have frequently seen meteors four or five times as numerous as this on clear nights in the autumn.

On April 30 and following nights the Aquariads were well observed, and formed the best display of the epoch. I found them fairly conspicuous meteors with dense, flaky streaks, and their lines of flight covered extensive arcs. The average length of twelve paths was 39°·0, whereas the average length of ordinary meteors, derived from all my observations, is 11°·2. (The average of the forty-five conformable tracks registered by the Italian observers in 1870 was 34°·7.) I recorded the motions as ranging between slow and swift. These Aquariads are remarkable for their long, graceful flights, rather than for any extreme degree of visual velocity, though were the radiant higher, they would doubtless appear much swifter, and their apparent paths must cease to exhibit abnormal length.

The bright streaks generated by these meteors are very useful as affording the means of recording their directions with great accuracy. From twelve paths I find the radiant at 337° − 2½°, which must be within 2° of probable error. Nine of the meteors agree well with this position, and the three remaining tracks pass within a few degrees of it, but the radiant may be diffuse to the extent of 5° or 7°, for I cannot otherwise explain the three slightly discordant meteors, the directions in each case having been well observed.

The radiant point of this shower is therefore close to *η Aquarii* and 11° W. of a mean of three positions given by Col. Tupman. It agrees so closely with the radiant of Halley's comet, and among other favouring circumstances, the shower is one of such pronounced and definite character, that the identity of the two orbits seems placed beyond doubt. Comparing the radiants, we have the following figures:—

Halley's Comet	May 4	337° ± 0°
Tupman's Aquariads	April 30–May 6	337 − 2½

The maximum occurs on May 6 according to my recent observations. At the time of nearest approach to the Earth the comet's orbit is 0·061 (Sun's distance = 1) below the Earth, which is equivalent to nearly 5¾ millions of miles. This interval is relatively inconsiderable when we remember to what enormous distances from the nucleus the material of the comet probably extends. The facts appear to present another excellent instance of agreement between a periodical comet and a very conspicuous meteor shower. The latter should now be specially looked for at observatories much further south, where the conditions are more favourable. In our latitude the radiant at 337° −2½° does

not clear the horizon until about $13^h\ 45^m$, when daybreak is already becoming strong in the N.E. sky. At southern stations, however, there would be a longer interval available for observation, and the greater elevation of the radiant must greatly enhance the richness of the shower. But while the low altitude of the radiant, as seen from this country, detracts from the numerical strength of the display, it has the effect of increasing the conspicuous aspect of the meteors, and their long flights right across the firmament create an impression not soon forgotten.

The following are the observed paths of eleven Aquariads recently seen here, and one recorded in 1880:—

No.	Date.	h .m	Mag.	Path From α_o	δ_o	To α_o	δ_o	Length of Path.	Appearance.
1	1880, May 2	14 23	3	324	+14	311	+28	18	Slowish; streak.
2	1886. Apr. 30	14 48	3	346	+30	355	+54	25	Swift; streak.
3	May 1	14 37	3	300	− 2	280	− 0½	19	Swift; streak
4	3	14 31	3	345½	+43	135	+68	66	Slowish; streak.
5	4	14 20	2	310	+ 3	270	+11	41	Slowish; streak.
6	5	14 6	4	334½	+28	327	+68	40	Slow; streak.
7	5	14 18	2	301	−16	270	+23½	30	Swift; streak.
8	6	13 55	4	323	+30½	224	+79	62	Slowish; streak.
9	6	14 11	2	306½	+21	202	+31	87	Slow; streak.
10	6	14 28	5	299	+24	274	+33	22	Rather swift.
11	6	14 32	4	334	+22½	332	+33	10½	Swift; streak.
12	6	14 36	3	301	+19½	250	+38½	47	Slowish; streak.

May 2 and 7 were cloudy, and May 8 clear only in the early part of the night. On May 9 I obtained a good view of the eastern sky between 14^h and 15^h, and saw six meteors, but the radiant in *Aquarius* gave no sign of continued activity.

I cannot account for the wide difference between my radiant point and that adopted by Col. Tupman. To get a good centre I took the precaution to watch the S.E. and N.E. sky alternately, so as to secure paths placed nearly at right angles. If Col. Tupman observed these Aquariads chiefly in the southern sky the motions would be in Right Ascension, and would give the Declination of the radiant well, while the R.A. would probably be doubtful to the extent of 10° or 15°. This is the most feasible explanation of the discordance that occurs to me.

The fine shower of Aquariads which, with early Perseids, form the well-defined meteoric epoch of July 27–30, have a radiant point at about 340°–12°, near *δ Aquarii*, and ten degrees south of the May Aquariads.

My late observations supply definite evidence of a considerable number of minor radiant points. The best of these are at 234°+10°, near *α Serpentis*, at 254°−21°, near *ρ Ophiuchi*, at 189°+58°, near *ε Ursæ Majoris*, and at 239°+46°, on the N.W. borders of *Hercules*.

Bristol: May 11, 1886.

Observations of Comets d 1885 (*Fabry*), *e* 1885 (*Barnard*), *and a* 1886 (*Brooks*), *made at the Royal Observatory, Greenwich.*

(*Communicated by the Astronomer Royal.*)

The observations were made with the East or Sheepshanks Equatorial, aperture 6·7 inches, by taking transits over two cross wires at right angles to each other, and each inclined 45° to the parallel of Declination.

Comet d 1885.

1886.	Greenwich Mean Solar Time.	Observer.	✓−★ R.A.	Corr. for Par. and Refract. in R.A.	✓−★ N.P.D.	Corr. for Par. and Refract. in N.P.D.	No. of Comp.	Apparent R.A.	Apparent N.P.D.	Comp Star.
	h m s		m s	s	′ ″	″		h m s	° ′ ″	
April 9	15 21 31	H. T.	+2 42·83		− 1 24·6		3			*a*
	15 21 31		+2 33·90		+ 8 36·6		3			*b*

Comet e 1885.

April 25	9 36 49	H.	+6 22·70	−0·10	+ 5 28·8	+ 5·0	4	1 40 13·35	50 5 32·1	*c*
	9 40 44		−7 30·20	−0·90	+11 10·8	+32·7	1	1 40 15·52	50 6 9·7	*d*
	9 59 45		+4 12·80	+0·24	− 6 25·4	−22·2	1	1 40 6·12	50 5 10·7	*e*
26	9 14 24	L.	+6 44·50	+0·48	− 7 45·2	−17·0	1	1 40 35·79	49 52 8·7	*f*
	9 18 57		+7 16·75	+0·28	− 1 37·9	− 9·9	2	1 40 38·58	49 51 59·2	*g*
May 3	13 33 45	H. T.	−0 33·88	−0·43	− 3 30·1	−11·1	6	1 38 57·03	49 31 44·3	*h*

Comet a 1886.

	Greenwich Mean Solar Time.	Observer.	☄−★ R.A.	Corr. for Par. and Refract. in R.A.	☄−★ N.P.D.	Corr. for Par. and Refract. in N.P.D.	No. of Comp.	Apparent R.A.	Apparent N.P.D.	Comp. Star.
1886.	h m s		m s	s				h m s	° ′ ″	
April 29	11 35 9	H. T.	−1 2·25	−0·22	− 1 36·1	− 6·0	2	0 36 55·38	28 41 50·1	*i*
	11 35 9		−1 7·50	−0·22	− 3 9·8	− 6·1	2	0 36 57·16	28 41 58·3	*k*
	11 35 9		−7 30·75	−0·22	− 7 4·6	− 6·5	2	0 36 56·33	28 41 52·6	*l*
30	9 12 33		+2 25·50	+0·14	+ 6 19·8	− 5·3	2	0 44 3·61	29 8 36·9	*m*
May 1	9 49 54	A. D.	+5 34·20	+0·07	+10 12·2	− 4·9	5	0 55 54·03	29 21 52·3	*n*
2	9 42 29	L.	+0 12·83	+0·08	− 5 22·4	− 6·7	3	0 59 17·89	30 12 56·8	*o*
	10 4 13		+1 53·50	+0·07	− 2 23·6	− 6·4	1	0 59 30·29	30 14 11·7	*p*
3	10 1 39	A. D.	+6 47·67	+0·04	+ 2 44·2	− 5·8	3	1 6 40·19	30 47 51·7	*q*
	10 10 27		−1 6·00	+0·02	− 2 59·9	− 6·6	5	1 6 42·20	30 48 7·6	*r*

Mean Places of Comparison Stars.

Star's Name.	R.A. 1886·0.	N.P.D. 1886.0.	Authority.
	h m s	° ′ ″	
(*a*) Arg. Zone +39° No. 5099 (?)	23 26 25·66	49 51 3·3	Bonn Observations, vol. iv.
(*b*) Arg. Zone +40° No. 5099 (?)	23 26 40·86	49 41 51·3	,, ,, ,,
(*c*) τ Andromedæ	1 33 51·29	50 0 2·7	Greenwich 9-year Catalogue.
(*d*) Groombridge 400	1 47 47·14	49 54 18·3	Radcliffe.
(*e*) W. B. (2) I. 785	1 35 53·58	50 11 50·2	Weisse's Bessel (2).

Star's Name.	R.A. 1886·0.			N.P.D. 1886·0.			Authority.
	h	m	s	°	′	″	
(*f*) τ Andromedæ	1	33	51·29	50	0	2·7	Greenwich 9-year Catalogue.
(*g*) Lalande 3024	1	33	22·03	49	53	38·7	Lalande.
(*h*) W. B. (2) I. 863	1	39	31·73	49	35	14·9	Weisse's Bessel (2).
(*i*) Arg. Zone + 61° No. 162	0	37	58·35	28	43	22·5	Bonn Observations, vol. v.
(*k*) Arg. Zone + 61° No. 164	0	38	5·38	28	45	4·5	,, ,, ,,
(*l*) Oeltz. Arg. (N) 801	0	44	27·83	28	48	54·1	Oeltz. Arg. (N).
(*m*) Oeltz. Arg. (N) 746–47	0	41	38·46	29	2	13·7	,, ,,
(*n*) Lalande 1562	0	5	20·26	29	11	35·3	Lalande
(*o*) Arg. Zone + 59° No. 180	0	59	5·46	30	18	16·3	Bonn Observations, vol. v.
(*p*) Arg. Zone + 59° No. 176	0	57	37·20	30	16	32 0	Rümker.
(*q*) Arg. Zone + 59° No. 181	0	59	52·93	30	45	3·5	Bonn Observations, vol. vi.
(*r*) Arg. Zone + 58° No. 201	1	7	48·66	30	51	4·5	,, ,, ,,

Notes.

April 9. Bright condensation at the head and a long tail. No striations or other detail discernible with a power of 310.
April 29. Comet fairly bright, but no nucleus.

The observations are corrected for parallax and refraction. The initials H. T., A. D., L., and H. are those of Mr. Turner, Mr. Downing, Mr. Lewis, and Mr. Hollis respectively.

Royal Observatory, Greenwich:
1886, *May* 12.